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A Brief Overview of Actor-Network Theory: Punctualization, Heterogeneous Engineering & Translation

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Introduction

Actor-Network Theory (ANT) is notoriously difficult to summarize, define or explain. There are a number of reasons for this, not least of which is ANT's unrelenting attack on the categories and concepts that have been part of Western thought for centuries.

> *"Truth and falsehood. Large and small. Agency and structure. Human and non-human. Before and after. Knowledge and power. Context and content. Materiality and sociality. Activity and passivity…all of these divides have been rubbished in work undertaken in the name of actor-network theory"* (Law 1999, p.3).

Despite this intimidating ontological complexity ANT has spread across a number of disciplines. From its humble beginnings in the sociology of science and technology, the ANT diaspora has spread to sociology, geography, management and organization studies, economics, anthropology and philosophy.

In the English-speaking world ANT is frequently associated with three writers: Michel Callon, Bruno Latour and John Law. These writers were the first to use the term "Actor-Network Theory" to describe their particular approach to scientific and technical innovation and, over the past 30 years, they (and others) have written a number of articles and books that attempt to summarize, clarify and critique ANT (Akrich & Latour 1992; Callon 1999; Callon & Law 1997; Hassard, Law & Lee 1999; Latour 1987; Latour 1996; Latour 1999; Latour 2005; Law 1992; Law 1997; Law 1999; Law 2007; Lee & Brown 1994; Neyland 2006).[1]

These overviews, though, speak of ANT in the abstract, divorced from particular case studies. This is a serious problem for a theory that is best understood as something that is *performed* rather than something that is *summarized* (Law 1997; Law & Singleton 2000). Thus, speaking of ANT in the abstract often ends up confusing readers and potential "users" of ANT.[2] This confusion is compounded in the various assertions of what ANT is within these and other abstract summaries: Law (1999) contends that it is "a ruthless application of semiotics" (p.3) and a "semiotic machine for waging war on essential

[1] See also the ANT Resource Website at http://www.lancs.ac.uk/fass/centres/css/ant/antres.htm

[2] See the dialogue between a Professor and a Student regarding the difficulty of doing an ANT study in Latour 2005, pp. 141-159. This particular discussion resonates with anyone who has ever attempted to explain ANT without doing ANT.

differences" (p. 7)[3]; Latour (1999) argues that ANT is "simply another way to be of being faithful to the insights of ethnomethodology" (p.19); while Lee & Brown (1994) point out that "ANT is so liberal and so democratic that it has no Other…it has made itself into a "final" final vocabulary" (p.774). To add to this confusion, ANT has gone by different names: The Sociology of Translation (Callon 1980, 1981, 1986b), Co-Word Analysis (Callon, Law & Rip 1986) and Actant-Rhizome Ontology (Latour 1999).

Undeterred by these variations, I contend that ANT contains within it concepts that, when abstracted from the multiple trajectories of ANT, can be used as tools to better reveal the complexities of our sociotechnical world. To explore this I am putting forward another overview of ANT that draws upon those concepts that make ANT a valuable tool within the social study of technology. The goals (and reader expectations) of this overview should be quite modest though. I am hardly an adherent of ANT; I came to it through my studies of the sociology, philosophy and history of technology and as such I share many of the normative critiques of ANT that have emerged alongside its popularity (Feenberg 1999, 2002, 2003; Radder 1992; Winner 1993). ANT is both intriguing and frustrating for this type of exercise. Intriguing because of the potential for re-thinking taken for granted ideas that are problematized through such a radical approach. It is frustrating because ANT cannot be reduced, once and for all, to a catch-all theory that can be universally applied. In other words, one person's use, or reading, of ANT may differ considerably from others.

ANT – A Brief History & Overview

A variety of intellectual traditions are detected in ANT: Foucault's (1977) theory of power and micro-politics, semiotics, anthropology (Douglas 1966) and the philosophy of Michel Serres. However, its most identifiable intellectual predecessor is the radicalized sociology of science and technology that emerged in the wake of Thomas Kuhn (1962; see also Bloor 1991 [1976]). Along these lines ANT's most profound resonance is within Science and Technology Studies (STS). Latour's work on Pasteur (1988) and explorations in the sociology and philosophy of technology (1988, 1991, 1992, 1994), Law's work on the TSR 2 aircraft (1988, 1991), 17th century Portuguese expansion (1986, 1987) and his engagements with the history of technology (1987, 1991) and Callon's studies of the Electric car (1986a, 1987) and the Scallops of St. Brieuc Bay (1986b; Law & Callon 1989) are all significant for the ways in which these studies contribute to our knowledge of scientific and technical innovation.

Methodologically, ANT approaches "science and technology in the making" as opposed to "ready made science and technology" (Latour 1987). What this entails are micro-level studies of the places where science and technology come into being: labs, institutes, government departments, boardrooms and funding agencies. Once here ANT sets out to "follow the actors"; a confusing dictum if only because there are so many actors within any given network, including some who may emerge and disappear long before a

[3] See Law & Mol (1994) & Law (2007) on ANT as a theory of Material Semiotics

recognizable network is finalized. As such, it is usually the case that ANT looks to the network builders as the primary actors to follow and through whose eyes they attempt to interpret the process of network construction.[4] These network builders, typically, consist of engineers and scientists. From this perspective, ANT attempts to "open the black box" of science and technology by tracing the complex relationships that exist between governments, technologies, knowledge, texts, money and people. It are these connections that result in science and technology, and by examining them it becomes easier to describe why and how we have the science and technology that we do.

These questions – why and how we have the science and technology we do – have influenced a number of philosophical, sociological and historical accounts of technology so it is not surprising that ANT shares many basic assumptions with them. All are committed to examining the historical and social contexts and contingencies of scientific knowledge and technology. In doing so they are explicitly rejecting a linear model of scientific and technical change and with it any hint of social, technical or scientific determinism, reductionism or autonomy.

Despite these epistemological similarities ANT includes distinct qualities and characteristics that makes it a unique approach in and of itself. The first of these is the oxymoron "actor-network". How can something be both an actor and a network? Does this not contradict conventional notions of agency & structure and content & context that have guided social thought since Descartes? The answer to this question, briefly, is that everything can be considered both an actor and a network – it is simply a matter of perspective. Everything, then, is an actor-network:

> "*reducible neither to an actor alone nor to a network…An actor-network is simultaneously an actor whose activity is networking heterogeneous elements and a network that is able to redefine and transform what it is made of*" (Callon 1987, p.93).

ANT also distinguishes itself from other sociotechnical approaches by considering both human and non-human elements equally as actors within a network. In other words, we should employ the same analytical and descriptive framework when faced with either a human, a text or a machine:

> "*An actor in ANT is a semiotic definition – an actant – that is something that acts or to which activity is granted by another…an actant can literally be anything provided it is granted to be the source of action*" (Latour 1996, p.373; see also Callon & Latour 1981, p.286).

It is as a nod to semiotics, which posits that signs have meaning only in relation to other signs, that ANT argues that both humans and non-humans actors be understood within a network wherein their identity is defined through their interaction with other actors. As

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[4] As John Law (1991) writes about Thomas Hughes (a historian of technology whose work on sociotechnical systems [1979, 1983] was quite influential on ANT), "he does not spell out a method. He simply uses one. What he does is follow Edison and the other system-builders wherever they go" (p. 11).

such, ANT theorists consciously use the term "sociotechnical network" or "heterogeneous network" in order to overcome what they see as an unnecessary duality between humans and non-humans. This ontological leveling, although philosophically radical, derives from empirical observation of activities in labs, research centres and field tests where texts, technologies and humans all play equally important roles in the construction of actor-networks (Callon & Latour 1981; Latour 1987; Law 1994). This particular aspect of ANT, called generalized symmetry (Callon 1986a), reminds us that although we recognize that the social is materially heterogeneous and the technical is socially heterogeneous these ideas are rarely applied.

> *'Often in practice we bracket off non-human materials, assuming they have a status which differs from that of a human. So materials become resources or constraints; they are said to be passive; to be active only when they are mobilized by flesh and blood actors. But if the social is really materially heterogeneous then this asymmetry doesn't work very well. Yes, there are differences between conversations, texts, techniques and bodies. Of course. But why should we start out by assuming that some of these have no active role to play in social dynamics?"* (Callon & Law 1997, p.168).

As you may have surmised, a network in the ANT sense should not be confused with the conventional sociological or technical applications of this concept:

> *"...we are not primarily concerned with mapping interactions between individuals...we are concerned to map the way in which they [actors] define and distribute roles, and mobilize or invent others to play these roles"* (Law & Callon 1988, p.285).

To do this ANT studies associations between heterogeneous actors - associations that are proposed and attempted, failures or successes. There is literally nothing else, for ANT, except associations. These associations, in turn, can be used to describe how networks come to be larger and more influential than others, how they come to be more durable through enrolling both social and material actors, and where power comes from and how it is exerted. Power (or lack thereof) and connectivity are intertwined then, to speak of one is to speak of the other. We should not ask if this network is more powerful than another; rather, we should ask if this association is stronger than another one. Any actor-network, then. is the effect, or result, of the connections that constitute it:

> *"When you simply have power – in potentia – nothing happens and you are powerless; when you exert power – in actu – others are performing the action and not you...[power] as an effect, but never as a cause"* (Latour 1986, p.265).

This idea of a heterogeneous, or sociotechnical, network can subsequently be used to describe everything. This is another of the radical moves that ANT makes: arguing that everything – people, organizations, technologies, nature, politics, social order(s) – are the result, or effect, of heterogeneous networks. This has two significant consequences. First, the social world is neither entirely social nor inevitable. Any kind or form of social

ordering - be it work, economics or education - is the effect of the associations within a heterogeneous network. Even people are the effect of a heterogeneous network. Thus, for ANT there are no causes, only effects. There are no essences, only heterogeneous networks.

Second, the division between micro and macro actor-networks is not to be assumed *a priori*. There are, obviously, differences between the two; but, like the analytical and conceptual symmetry between the social and the technical, ANT turns away from conventional distinctions and dichotomies. Thus, following the language of generalized symmetry, we are not to change frameworks when dealing with actor-networks of different sizes. To do so would be to employ a theoretical and conceptual dualism:

> *"which has the effect of reifying those who are successful while obscuring the methods by which such large-scale social control is achieved and precariously maintained…treat power as an effect of sets of variegated and differentially successful strategies to enroll others rather than as a cause of that success"* (Law 1986, p.5; see also Callon & Latour 1981 for an explanation of this point).

Organizations, individuals, institutions, nations, corporations – if these are bigger or more powerful than other actor-networks we do not start with this difference and work from there; rather, it is this difference that needs to be explained. For example, if we begin by saying that Organization X is a powerful and influential actor, we begin to impart a difference between it and other networks, thus implying an essential characteristic that is static. Size, power and influence are an effect that is performed by other actors, not a permanent condition:

> *"Power is always the illusion people get when that are obeyed…people who are 'obeyed' discover what their power is really made of when they start to lose it. They realize, but too late, that it was 'made of' the wills of all the others"* (Latour 1986, p.268).

Thus, once again, and this requires repeating, for ANT, to study any type of organization, social order, technical innovation or scientific discover is to study the connections between heterogeneous actors enrolled within a network. If we assume size and power without explaining how it is performed and made durable we miss out on explaining how it is that the sociotechnical world we inhabit is performed.

Beginning in the mid 1990s ANT moved beyond STS and is now considered to be a widely applicable theory of the social world. Latour (2005) describes the shift as a process of developing "an alternative social theory to deal with the new puzzles uncovered after carrying out our fieldwork in science and technology (ff. 1, p. 2).

> *"ANT started with research into the history and sociology of science, tried first to provide a 'social' explanation of scientific facts, failed to do so, and then, from this failure, it drew the conclusion that it was the project of a social explanation of everything that was itself wantin"* (Latour 2003, p.35).

Because the author of this paper came to know ANT through technology studies and the philosophy of technology it should not be surprising that the preceding overview is influenced by ANT studies that resonate with these disciplines. In what follows I present a more detailed overview of this particular reading of ANT by examining 3 concepts unique to ANT: 1) Black-Boxes/Punctualization; 2) Engineer-Sociologist/Heterogeneous Engineer; and, 3) Translation/Delegation.

Black-Boxes & Punctualization

> *What is needed is an understanding of technology from the inside, both as a body of knowledge and as a social system. Instead, technology is often treated as a 'black box' whose contents and behaviour may be assumed to be common knowledge.*
> *- E. Layton, 1977 (qtd. in Pinch & Bijker 1984, p. 404).*

Using the term black box to describe a technical object is not unique to ANT. Most sociological, philosophical and historical approaches to technology take, as a starting poin, the identification of their object of study as a black box. A black box could be a computer, a car, a television or any other technical object that operates as it should. When this occurs, the complex sociotechnical relationships that constitute it are rendered invisible, or black-boxed.

This concept was originally used in information science to make opaque the inner complexity of technologies in order to reduce complex technology to its inputs and outputs. Taken up by the sociology of science, the concept was used to refer to the unquestioned acceptance of the scientific method as objective truth. Reflecting the Mertonian tradition in the sociology of scientific knowledge, sociologists undertook investigations of the social relations and processes of science but left the cognitive basis of science unexamined (Whitley 1972; Mulkay 1979). Thus, the scientific method was black boxed in the sociology of science until Kuhn (1962) identified the historical contingencies of scientific paradigms, leading to the turn from a sociology of science to a sociology of scientific knowledge. The consequence of this move was to suggest that there is nothing epistemologically special about scientific knowledge.

Adapted for technology studies, a black box is a technical artifact that appears self evident and obvious to the observer. Technologies as mundane as a seat belt (Latour 1992) all the way up to nuclear weapons (MacKenzie 1996) can both be considered equally complex black boxes that depend on techniques, materials, thought processes and behaviour. Opening the black box of technology leads the way to an investigation of the ways in which a variety of social aspects and technical elements are associated and come together as a durable whole, or black box.

As noted, the term black box is not unique to ANT. However, the concept of "punctualization" is similar and by noting its usage we can begin to identify perspectives

and methods that are unique to ANT. Punctualization refers to the process by which complex actor-networks are black boxed and linked with other networks to create larger actor-networks, "the process of punctualization thus converts an entire network into a single point or node in another network" (Callon 1991, p.153).[5]

Two points emerge from this conceptualization. First, we can better illustrate the idea that everything is both an actor and a network – it simply depends on perspective. A computer is a complex network of social practices and technical processes. This same computer, though, can also be a single node, punctualized, within a file-sharing network. Second, technical objects are not things so much as they are processes. The relationships between the heterogeneous actors that come to stand behind technologies are never static and unchanging - they are constantly being performed. As such, to identify a particular technology as being black boxed is also to recognize the precariousness of this often times temporary situation. All black boxes are "leaky" (Callon & Latour 1981) meaning that there will always be competing ideas and initiatives that seek to open black boxes that have been punctualized within larger actor-networks.

> *"Punctualization is always precarious, it faces resistance, and may degenerate into a failing network. On the other hand, punctualized resources offer a way of drawing quickly on the networks of the social without having to deal with endless complexity"* (Law 1992, p.385).

Engineer-Sociologist/Heterogeneous Engineering

So, how do we set out to open black boxes? Which actors do we follow? And, what are we to look for?

> *"The impossible task of opening the black box is made feasible (if not easy) by moving in time and space until one finds the controversial topic on which scientists and engineers are busy at work. This is the first decision we have to make: our entry into science and technology will be through the back door of science in the making, not through the more grandiose entrance of ready made science"* (Latour 1987, p.4).

Methodologically, ANT follows the lead of historian Thomas Hughes (1979; 1983) and turns its attention to the System Builders. At the individual level these are usually scientists and engineers while larger actors typically include representatives of industry and government. These are the actors (for many ANT studies) who initiate scientific and technical innovation and exert influence over its direction and trajectory. In this way, ANT exhibits its ethnographic bent: micro-level studies of the labs and boardrooms tracing how actors exert influence over the trajectory of scientific and technical innovation.

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[5] See also the process of simplification and juxtaposition (Callon 1987).

During this process these actors do not shape technology apart from the social world. Rather, they are constantly defining and re-defining a sociotechnical world. In other words, the divide between scientific and technical content and social context is nullified when we actually observe the process of technical innovation. Guiding this process are "*sociologist engineers*" (Callon 1987). This term derives from Callon's study of the development of the electric car in France in the 1970s. What Callon discovered was that the engineers involved in the project were addressing social and technical problems simultaneously:

> "*the project conjectured not only that the technoscientific problems could be overcome but also that French social structure would change radically*" (Callon 1987, p.84).

According to Callon, the engineers were contributing to a debate between competing sociological interpretations of the future of French society. They were, simultaneously, designing both a technology and social world in which it had a place.

The process that is occurring here is termed "*heterogeneous engineering*" (Law 1987). Large-scale technological innovations (like the electric car) or endeavors (like the Portuguese expansion into India in the 16th century) are:

> "*the function of the interaction of heterogeneous elements as these are shaped and assimilated into a network*" (Law 1987, p.113).

If we wish to understand the processes by which the sociotechnical world emerges we should not limit ourselves to one particular perspective (economics, politics, the social) but rather attempt to understand how all of these elements combine to create the phenomenon in question.

By introducing these concepts ANT differentiates itself from a branch of technology studies called the Social Construction of Technology (SCOT; see Pinch & Bijker 1984). Whereas SCOT looks for relatively stable social groups to explain the meanings ascribed to technical objects, ANT seeks a symmetrical account of the social and the non-social in describing how and why we have the technologies we do,

> *"In explanations of technological change the social should not be privileged. It should not, that is, be pictured as standing by itself behind the system being built and exercising a special influence on its development…other factors – natural, economic or technical – may be more obdurate than the social and may resist the best efforts of the system builder to reshape them. Other factors may, therefore, explain better the shape of the artifacts in question and, indeed, the social structure that results"* (Law 1987, p.113).

Translation/Delegation

In the description of ANT thus far we have examined what it is that ANT focuses their attention on (technical black boxes), how they conceptualize the emergence of these technologies (heterogeneous engineering) and who initiates these technologies (sociologist-engineers). What is missing, though, is a better conceptualization of what is actually occurring during the process of technical innovation.

The term "translation" can provide this conceptualization. In the methodology detailed thus far, it seems obvious that technology cannot be presupposed as an autonomous thing that exists outside of the social world. Technologies contain a variety of political, social and economic elements as well as science, engineering, and the particular histories of these practices. Translation, as developed by the French philosopher Michel Serres, is a term that attempts to overcome the arbitrary divisions between these related aspects. In his work, Serres deliberately crosses disciplinary boundaries by moving:

> *"from information theory to myth by way of examples drawn from literature and art"* (Brown 2002, p. 1).

Translation:

> *"appears as the process of making connections, of forging a passage between two domains, or simply as establishing communication"* (It is) *"an act of invention brought about through combination and mixing varied elements"* (Brown 2002, pp. 3-6).

Within ANT translation is a concept that bridges the gap between the varied aspects that are combined in technology. "Translation involves creating convergences and homologies by relating things that were previously different" (Callon 1981, p.211). If there are countless entities and meanings built into technology, translation is the process by which these elements are related in a sociotechnical network, the process by which "the identity of actors, the possibility of interaction and the margins of manoeuvre are negotiated and delimited" (Callon 1986b, p. 203; see also Callon 1981; Latour 1993). Translation can be considered the general movement of technological development over time: how it is that ideas and plans are turned into staffed research labs, how people and institutions are shaped to believe the same thing that engineers believe, and how users are able transform the technology to better meet their goals. By not abiding by the distinctions that isolate seemingly dissimilar aspects of technological development, ANT is able to focus on the numerous moments of translation as they are enacted in the process of building the sociotechnical.

Translation is paradoxical: At once it appears as a unique conceptualization to frame the processes that contribute to and result from the relationship between the social and the technical but its potential is hindered by the very of nature of term's complexity and seemingly infinite applicability. To reduce this, I turn to Latour's concept of delegation as a particular interpretation of translation.

For Latour delegation describes the reciprocal relationship between the social and the technical. In any situation in which technology is used, it is used to delegate, or translate, a major effort into a minor effort. We delegate to technologies the work of many humans. In turn, technologies delegate behaviour back onto the social. We act as we do, not by some idealistic notion of free choice, but because our actions are bounded by technologies that delegate how and what we can do within a sociotechnical network.

> *"Delegation, then, is a particular instance of translation whereby the social and the technical co-constitute each other – to read the social from the technical is similarly to read the technical from the social"* (Latour 1991, 1992)

Conclusion: Critical & Evaluative Potentials of ANT

From the description above ANT can potentially be used for a variety of tasks. The most relevant of these tasks is exploring the questions of why and how we have the technologies that we do. ANT provides a research trajectory that can reveal complexities and contingencies that are too often overlooked in accounts of technology.

Unfortunately, ANT does not easily lend itself to dialectical sociotechnical interpretations. The social study of technology should not be limited to rejecting technological determinism or social reductionism (although this is invaluable) – it should also attempt to point out alternative trajectories to technological modernity. This is difficult using ANT on its own primarily because of its methodological rules. ANT is characterized by an exclusive emphasis on case studies and empirical observation, leading to situations where researchers simply report what they see and intangible elements like values and norms are not recognized (Radder, pp.145-6). Thus, what the social is, or how it is conceived, become impoverished when we understand the tools of social research to consist of :

> *"surveys, interviews, opinion polls, participant observation, statistical analyses, and so on"* (Callon 1987).

This toolbox does little to inspire an understanding of the social that accounts for human experience outside of pre-established categories or models. The result of this quantitative leveling is an impoverished understanding of the sociotechnical due in part to a conceptual and methodological limitation what the social, and social research, can potentially consist of.

To remedy this, I encourage further exploration into the concept of translation. Translation emphasizes a more interpretive approach that looks at how ideas and modes of behaviour are sociotechnical nature. The question *what is being translated* as opposed to studying the mechanisms of translation opens ANT to new lines of inquiry.

On the other hand, ANT can also be used to better analyze and evaluate networks.

It is not surprising that some general understanding of what a network is has become part of the shared knowledge of contemporary culture. Networks are largely understood to be self-evident, unproblematic and largely unquestioned conceptual frameworks. As such, it would not be an exaggeration to say that networks have attained paradigmatic status across large sections of popular and academic culture.

Certainly one of the reasons for this paradigmatic status is the conceptual duality of networks. A network, in this sense, can be considered both form and process. On one hand, a network refers to a particular architectural form, or organizational structure, wherein people and institutions (amongst other entities) interact. On the other hand, the term network can also be considered a verb, a process that occurs within the networks. However, we should not be so quick to delineate between process and form. In some instances, networking precedes and shapes form and in other instances form shapes process. In short, networking and network should be understood as co-constitutive, inseparable dimensions of the same phenomenon.

Yet, despite this holistic view of networks, it has become increasingly evident that for the purposes of analysis and evaluation an analytical distinction between form and process is required. Across a number of countries public funds are increasingly being used to fund scientific and technical networks as a means to spur innovation, economic prosperity and an increased quality of life. These networks are subject to routine evaluations that gauge their efficacy and relevance. Although this may appear to be rather straight forward, network evaluation presents many obstacles for traditional evaluative frameworks. As Rogers et. al (2001) and others (Mote et. al. 2007) within the evaluation community point out, translating what we know about networks into a framework for evaluation is quite difficult. Very generally, the problem is that researchers do not know how to differentiate networks from other frameworks and as such rely on an evaluative model that is dependent on inputs and outputs. In practice there is nothing wrong with this. A thorough review of network inputs (individuals, money, infrastructure) and outputs (publications, patents) is essential for gauging the effectiveness of any given network. But, this particular approach disregards both the idea of network as process and the formal structure of networks. It is assumed that successful networking is key to the success of a network as measured by outputs, but there are no tools on hand to evaluate what actually happens within a network. If we reduce evaluation to inputs and outputs both the form and the process of a network are, at best, loosely related to the primary evaluative concerns. In short, the evaluation of research networks emphasizes everything but the network itself.

This is realized in a number of ways. First, most evaluations are conducted to assess the performance of individuals. Thus, translated to the evaluation of networks this results in conceptualizing the nodes as independent and autonomous entities. Of course this contradicts one of the essential characteristics of any network – the whole is more than a sum of its parts (Rogers et. al. 2001, p. 167). Second, network evaluation needs to move beyond simply noting connections and focus on describing the nature of these connections. Not all connections are equal, yet it is often the case that all connections are

considered equal despite the range in strength and weakness that connections necessarily embody. Thus, it is important to:

> *"move beyond simple descriptive exercises of who is connected to whom"* (Mote et. al. 2007, p.192).

The problem is clear – how to create an evaluative framework for networks that can account for the unique characteristics of networks. This means leaving behind lists of inputs and outputs and attempting to explore what happens in between the inputs and outputs. In other words, how do we evaluate both the "network" and "networking".

To some this may appear to be counter-intuitive; after all, it does not matter what the structure is as long as the results are consistent. However, it is becoming more evident that there is a link between the processes of networking and the forms that it takes and the overall efficacy of the network itself. Following up on Rogers et. al. (2001) point that while there has been an abundance of empirical contributions to network studies there has been "insufficient theoretical development of network analysis in general" (p.162) I believe that ANT can potentially open up new avenues of network evaluation by examining, first, the heterogeneous associations that constitute networks. And second, by paying closer attention to how networks are performed instead of attempting to provide a snapshot of a network based on inputs and outputs.

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